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ABSTRACT

Contextualised and ubiquitous learning are relatively new research areas that combine the latest developments in ubiquitous and context aware computing with educational approaches in order to provide structure to more situated and context aware learning. The majority of recent activities in contextualised and ubiquitous learning focus on mobile scenarios, with location as the primary contextual dimension. However, the meaning of context aware learner support is not limited to location based solutions, as it is highlighted by the educational paradigms of situated learning and communities of practice. This paper analyses learner participation as a contextual dimension of adapting graphical indicators of interaction data for engaging and motivating learners in participating and contributing to an open community. The analysis is based on interaction data and interviews with participants in a nine week lasting design study, during which we compared the effect of two indicators on the engagement of the participants in the group activities. The trend of study results supports the presumption that the learners' perception of their activity visualisations is context dependent. We found that more engaging visualisation polarised the participants in this group: while contributing participants were attracted to contribute more to the community, non-contributing participants were distracted by the same visualisation.

Keywords

Learner support, Self-directed learning, Information visualisation, Context-awareness, Evaluation

Introduction

Contextualised and ubiquitous learning are relatively new research areas that combine the latest developments in ubiquitous and context aware computing with educational approaches in order to provide new forms of access and support for situated learning. The majority of activities in contextualised and ubiquitous learning focus on mobile scenarios, in order to identify the relation between educational paradigms and new classes of mobile applications and devices (Naismith, Lonsdale, Vavoula, & Sharples, 2004). However, the meaning of context aware learner support is not limited to mobile learning scenarios by default. The educational paradigms of situated learning and communities of practice (Lave & Wenger, 1991) highlight the need for contextualisation of informal learning, particularly where learning activities are related to the workplace. In these scenarios learning processes are often unstructured, unguided, and sometimes even unintended.

Our previous work analysed the potential of contextualised visualisations of interaction data for supporting informal learning (Glahn, Specht, & Koper, 2008). We call such visualisations *action indicators*. They are called *smart indicators*, if the visualisation follows rule-based adaptation strategies (Glahn, Specht, & Koper, 2007; Glahn, Specht, & Koper, 2008). Such indicators may help actors to organise, orientate, and navigate through environments as well as reflecting on their actions by providing relevant contextual information for performing learning tasks, informally.

The purpose of our research is to identify variables and conditions for selecting and adapting visualisations of "interaction footprints" (Wexelblat & Maes, 1999) in order to provide context sensitive learner support in informal learning. Such learning usually takes place in unstructured environments, where *unstructured* refers to the lack of pre-defined roles and instructional designs. In these environments learners interact at different expertise and activity levels in changing or implicit roles. The footprints of user interactions can be used to determine the context of a learner (Zimmermann, Specht, & Lorenz, 2005) by defining rules for the boundaries of each context.

In order to evaluate the benefits of indicators for learning processes, we proposed an adaptation strategy for visualizing action information on team.sPace (Glahn, Specht, & Koper, 2007). It was necessary to evaluate the indicators of the adaptation strategy regarding their supportive effects and their contextual boundaries, because the design of the adaptation strategy is based on basic presumptions that were sound from the perspective of prior research. But could not be sufficiently grounded on empirical evidence. Therefore, this study is a qualitative exploration of the underlying design principles of contextualised learner support and focuses on the presumptions

made for the adaptation strategy. We analyse the contextual boundaries regarding the level of learner participation and if the proposed indicators are suitable for engaging learners in participating and contributing to a community.

The following sections this paper report on this evaluation. The next section discusses the conceptional background of our research. It compares and links psychological models and educational concepts with the findings of research on technology enhanced learning. The third section links the concepts to identify the gap for further research. This gap is used to set the question for research. The fourth section describes the setting of the evaluation. In this section the team.sPace system is introduced and the set-up of the indicators is explained. The fifth section links our research question and the setting towards the four hypotheses that were tested by our study. The method of analysing the setting regarding the given hypotheses is given in section six. Section seven reports the results of the automatically collected interaction footprints and the results of the interviews with participant. Finally, section eight discusses the results regarding the hypotheses and the implications for our research question.

Background

Butler & Winne (1995) reported that environmental responses on actions are crucial to learners for controlling and structuring their learning process. According to the authors, one result of triggered cognitive processes is the learner's decision whether and how to proceed with their interactions with an environment. This implies that the responses to the learners' activities influences the quality, pace, and duration of their future learning activities, which includes also the option of dropping out. Based on prior findings the authors introduced a system model of the cognitive processes that are crucial to self-regulated learning. The model focuses on how learners assess, relate and integrate external information with their prior knowledge and experiences to control their actions, tactics, and strategies of interaction with the environment. In this sense this is an evolutionary model, because it includes the learners' self-regulating capabilities to the responses given by an environment. The learners' actions and reactions are connected to their past experiences and are integrated into their knowledge. This integration is a *knowledge construction* process, in which the learners' prior knowledge is constantly assessed against the effects of their actions in an environment. Alas, the learners' experiences are evolving, and the resulting experiences influence the interpretation of external responses on a learner's actions. This is a well known effect in workplace related competence development (Wenger 1998; Elkær, Høyrup, & Pedersen, 2007; Chisholm, Spannring, & Mitterhofer, 2007).

There are two limitations with this model with respect to contextualised learner support. First, the model focuses mainly on the cognitive processes of a learner. Second, the model does not include concepts to explain the motivation of learners depending on the contexts of their actions; i.e. the model focuses entirely on the actions of a learner and how responses on this action lead to other actions. The emphasis of the cognitive processes in this model, leaves the context of a learner's actions abstract concepts of prior experiences or to the external setting. Therefore, the model helps to understand the cognitive processes underlying self-regulated activities, but provides little information about how to support such processes in varying contexts.

Lave & Wenger (1991) introduced the concept of *situated learning*. This concept reflects the social dimension of learning. Situated learning emphasizes that learning is always embedded and contextualized by the social practices of a community. The background for this research is mainly informal and non-formal learning as it can be found in the professions. In their later work the authors independently highlighted several dimensions and factors of contextualisation in learning (Lave, 1993) and contextual support for learning (Wenger, 1998).

Lave (1993) identified that the problem of context in learning has to focus on the relationships between local practices that contextualize the ways people act together, both in and across contexts. From this perspective is context constructed by social activity. At the same time the *context* limits the possible actions and the perception of their effects. . This means that learning cannot be reduced to a set of contextual learning *events*, but requires tight coupling to the social practices in which learning *processes* are situated.

From an analysis of field studies Lave (1993) deduces six dimensions that characterise the context of learning: *process*, *group or peers*, *event or situation*, *participation*, *concepts*, and *organisation or culture*. In a later study, Wenger (1998) extracted 13 factors of supporting situated learning processes. These factors affect the learning process by allowing the development of the learners' identity and meaning regarding the social practices of their

learning contexts. Table 1 shows the relation between Lave's (1993) contextual dimension and Wenger's (1998) context factors.

For our research Lave's (1993) and Wenger's (1998) notion of meaning is important. In our understanding of their work *meaning* is not necessarily coupled to predefined learning objectives (Lave, 1993), but is developed through the social interactions of the learners (Lave, 1993; Wenger, 1998). In other words, what is meaningful to the learners and what they learn varies in different contexts.

Table 1 shows the relation between Lave's (1993) high level context dimensions and Wenger's (1998) factors for supporting situated learning. This allows us to identify for a context dimension, which types of interpretations of the learning processes can be expected. In this study we focus at the level of participation as the primary context dimension. Therefore, we would expect that meaningful experiences will be related to the following factors: *presence*, *interaction*, *involvement*, *personal identity*, *communal identity*, *boundaries*, and *community building*.

Compared to the model of Butler & Winne (1995) the contextual dimension and factors provided by Lave (1993) and Wenger (1998) help to argue design decisions for situated learning environments. The downsides of their concepts are that they provide the outer boundaries for technical support, but no guidelines for system design. However, the two theories of Butler & Winne (1995) and of Lave & Wenger (1991) are not mutually exclusive: while the Butler & Winne's model allows us to understand reflection and motivation as *cognitive processes* that connected to social interaction, Lave and Wenger's work helps us to identify contextual factors that structure *social processes*. Therefore we choose both approaches as the theoretical framing on the educational psychology side of our research.

The idea of using information about a user's actions to provide meaningful information in return is not new from a technical perspective (Kobsa, 2001). In research on user modelling questions on how to track, store, and analyse user interactions in order to adapt or to personalise interactive systems are key issues since applications in Intelligent Tutoring Systems (ITS). Important components for contextualized support can be separated into the four levels *action tracking*, *action analysis and assessment*, *personalisation/adaptation*, and *system response*. The four levels have been generalised by Zimmermann, Specht, & Lorenz (2005) into a system-architecture for context aware systems. From the systemic modelling stance of the earlier discussion, this architecture can be seen as a counter part to the cognitive processes of Butler & Winne's (1995) model.

Table 1: contextual dimensions and contextual factor alignment

Lave, 1993 → / Wenger, 1998 ↓	**Process**	**Peers**	**Event**	**Partici-pation**	**Concept**	**World**
Presence		X	X	X		
Rhythm	X		X			
Interaction		X		X		
Involvement				X		
Value		X			X	X
Connections		X			X	X
Personal Identity			X			
Communal Identity		X		X		
Relations		X				
Boundaries		X		X		
Integration	X	X				
Community Building	X	X		X		

Wexelblat & Maes (1999) showed that traces of user actions – so called interaction footprints – can be used to support the navigation through unknown information, which is the underlying concept for social recommendation in technologically enhanced learning (Drachsler, Hummel, & Koper, 2008). Farzan & Brusilovsky (2004) analysed different kinds of interaction footprints in order to improve the quality of adaptive annotations. Others (Dron, Boyne, & Mitchell, 2001; Erickson & Kellogg, 2003; Kreijns, 2004) utilised interaction footprints for providing learner support in informal learning, without directly recommending contents or actions to the users.

Erickson & Kellogg (2003) provide some examples of supportive visualisations of interaction footprints with regard to social information in online spaces such as discussion forums. Such *social proxies* – as the authors call such visualisations – are "minimalist graphical representations that portray socially salient aspects of an online situation" (Erickson & Kellogg, 2003). One effect of presenting social proximity without recommending learning activities or navigational behaviour has been reported as *waylay*. The concept refers to how a user monitors the indicators for another persons' activities and then initiates contact (Erickson & Kellogg, 2003). Similar to this concept is *stigmergy* (Dron, Boyne, & Mitchell, 2001). While waylay refers to virtual landmarks which are used by users to structure and plan their social activities, stigmergy refers to pathways of activities that emerge through collaborative activities.

Kreijns (2004) identified an effect related to group awareness indicators on distributed activities of peer users, which the author calls *social affordance*. Social affordance refers to information that stimulates activities that are aligned to the social practice within a collaborative environment. Different to social proxies the group awareness indicators that were used by Kreijns (2004) provide only information about the recent activity of peer users, but not about the relations between the activities or the users involved. Social affordances rely on meaningful responses to a user's actions and on the users' ability to relate the responses to their actions. (Kreijns, 2004).

All three concepts – waylay, stigmergy, and social affordance – and the related approaches can be explained by the model of Butler & Winne (1995). They all provide external responses on the learners' actions, which can be used for self-assessment and self-regulation. It is also possible to associate each approach to one of the contextual dimensions of Lave (1993) and Wenger (1998). However, similar to other visualisations of interaction footprints, these approaches were not analysed regarding their situated effects (Glahn, Specht, & Koper, 2008).

Motivation for research

Although there is some evidence that context is a critical factor for learning, the related technology enhanced learning research has not analysed if learner support is context dependent. Therefore, it is not possible to infer from prior research how contextualised visualisations influence engagement and reflection in informal learning. This gap in research leads us directly to the motivation for research of this paper: *what is the effect of interaction footprint visualisations in different contexts?*

Regarding this research question, the main research interest is if waylay and social affordance are dependent to the participation level of users of online communities. Therefore, we chose the participation as the contextual dimension. For evaluating the initial adaptation strategy the levels of participation are distinguished as contributing and not-contributing. Regarding the effect of the visualisation, we are interested in how the indicator affects the engagement of the users in using team.sPace (Glahn, Specht, & Koper, 2007). Hence, we focused our research to the following question: *what are the effects of interaction footprint indicators on the engagement of users within a community information portal, depending on their level of participation?*

Setting

team.sPace

To answer this question we used the team.sPace system (Glahn, Specht, & Koper, 2007) in a nine weeks lasting design study within our department. team.sPace is a group information portal for online communities of practice, which jointly form a larger "learning network" (Koper et al., 2005). Each community in team.sPace is built around the topics and the interests of their participants. The participation in team.sPace is open and users can register and set

their personal information as they would do as if they were using any other social-software platform on the web. Figure 1 shows a typical view of team.sPace for an authenticated user.

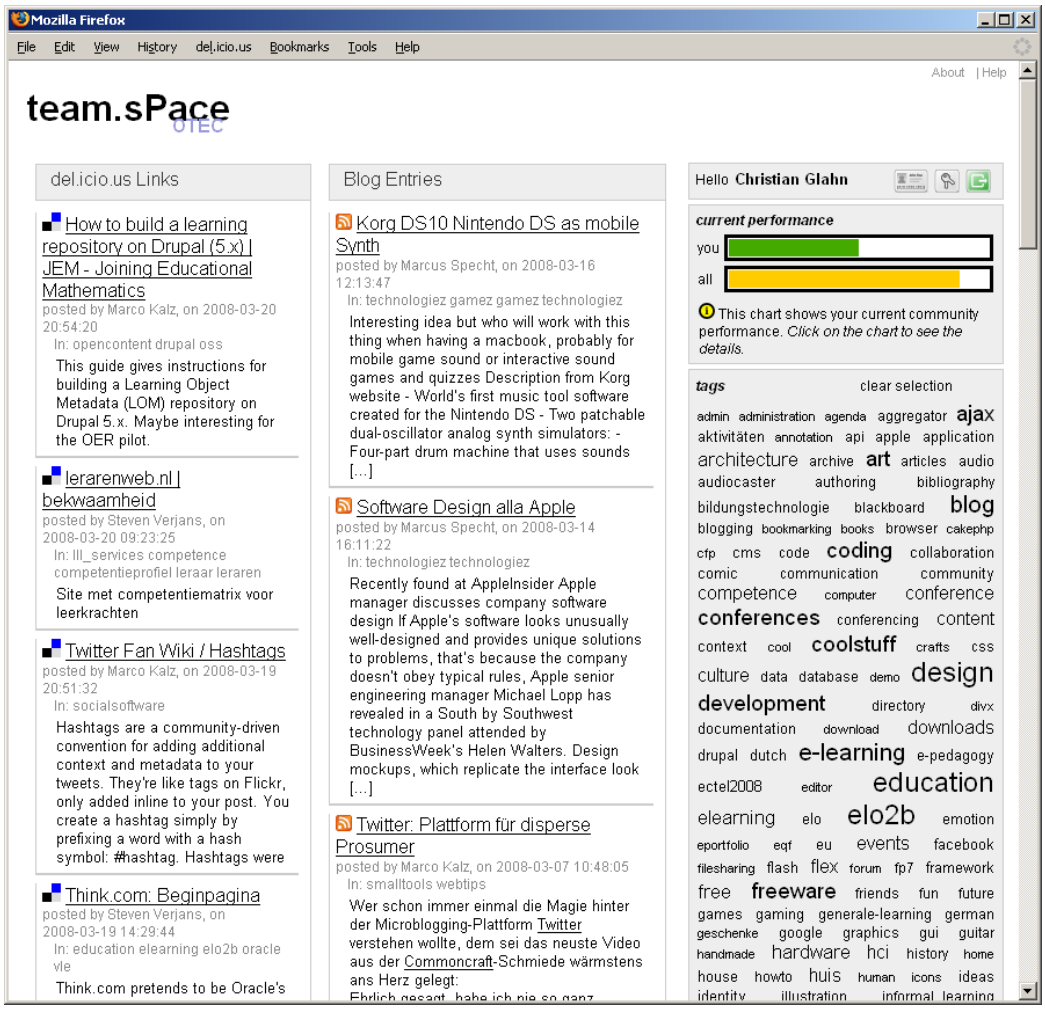

Figure 1: team.sPace screen for an authenticated user

The information presented in team.sPace is aggregated from the participants' weblogs and social bookmarks from delicious.com. The system aggregates the information from different services using information feeds. This allows the participants to use their tools while contributing and sharing information. In order to participate, the participants had to register and add the URLs of their personal services used to their user profile in team.sPace. After registering the preferred service URLs, team.sPace starts collecting information from these services. team.sPace limits the aggregated information to public resources that have been "tagged" by the participants. Private or untagged resources are ignored.

The front-end of team.sPace presents the aggregated information in three columns. The left column displays the latest social bookmarks, the middle column shows the latest weblog contributions, and the right column shows the tag cloud of the community. The separation of different contribution types is based on the different pace of the two information streams. While social bookmarks are frequently added, writing weblog entries requires more effort. If both resource types would be presented as a single stream of information, weblog contributions will hardly receive any visibility in the community. While the first two columns show the recent activities of the community members, the tag cloud displays those tags that are shared by them and provides an impression of the community's global interests. Besides the presentation of community interests, the tag cloud serves also as a navigation tool, through which users can apply filters to the other columns' content.

A small information indicator extends the basic functions. The visualisation of the indicator displays the recent activity of the current user. The information shown is based on the user's recent contributions, the visits to the portal, the number of filters that were applied, as well as the contributions, which were accessed by the user through the portal. This indicator takes up the concepts of social proximity (Erickson, 2008) and group awareness (Kreijns, 2004; Kreijns & Kirschner, 2002).

Setting of the study

Two information indicators were provided for analysing the influence of context on the perception of interaction footprint visualisations. Each participant was randomly assigned to one of the indicators during registration time. Apart from the different indicators all participants had access to the same instance of team.sPace.

The first indicator was an activity counter. It displayed the interaction footprints of a participant. Each action of a participant is counted; and all actions have the same impact on the visualisation. The activity is visualised in a horizontal raster bar-chart (see Figure 2). This chart does not grow homogeneously with each action, but a participant has to "earn" each field with a pre-defined number of actions. With an increasing number of activated fields more actions are required for a new field, similar to the logarithmic activity scale that has been used by Kreijns (2004).

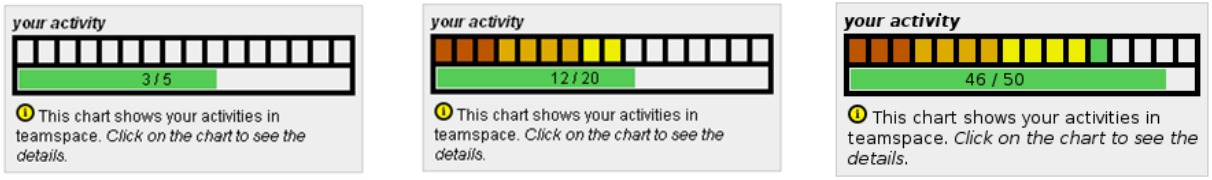

Figure 2: the activity counter after 3, 72, and 196 actions

The second indicator is a performance chart. This indicator is different to the first indicator in three ways. Firstly, it values the different activities with a factor that is multiplied to the user's activity points for that activity. This means that the activities have a different impact on the activity of the participant. For example an entry on a weblog is worth ten points, while selecting a link is only worth a single point. Secondly, the activity is not displayed in absolute terms, but relative to the activity of the most active user in the group. Finally, the indicator integrates a second bar, which charts the same information for the average participant of the community. The performance indicator is shown in Figure 3.

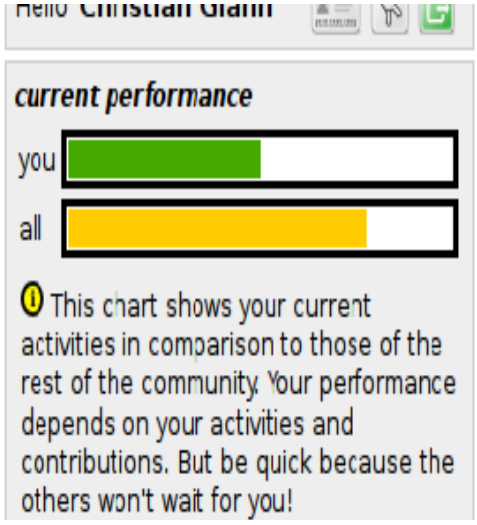

Figure 3: the performance indicator in action

Both indicators have a built in time constraint. The displayed information presents only the activity of the last seven days. This forbids users to pile-up actions and keeping their status while being inactive. Furthermore, both indicators provide the users detailed information of the underlying data. The users can access the details by clicking on the indicator. This action opens a small window, that shows the sources and the values in detail, which were visualised by the indicator. This assures that the users know what is displayed by the indicator.

Research questions

The design study intended to analyse visualising interaction footprints in relation to engagement and motivation at different stages of the learning process. Based on our previous considerations on self-regulated learning and context adaptation in the background section of this article, we formulate four research questions for this study.

1. Is the activity counter stimulating the engagement of non-contributing participants?
2. Will contributing participants ignore the activity counter after an initial phase of using team.sPace?
3. Does the performance indicator stimulate engagement and motivation in participating in the environment for contributing participants?
4. Is the performance indicator distracting for non-contributing participants?

The four research questions refer to the adaptation strategy, which has been previously proposed (Glahn, Specht, & Koper, 2007). This adaptation strategy argues that non-contributing participants should receive information about their actions on team.sPace in a way that is not competitive, while contributing participants receive information how they relate to others in the community. The purpose of this separation was to allow non-contributing participants to build relations to the community and to start contributing, without being distracted by strong performing participants.

Method

In order to come as close to the learning processes within a community of practice, the study has been conducted with the participation of selected researchers of our department. The group of scientific "knowledge workers" was selected to identify the design principles for supporting incidental learning processes in collaborative information organisation. The invited participants were selected affording to the similarity of their research topics, while previously these persons were not collaborating intensively with each other. All researchers in this group have a joint research interest of supporting lifelong competence development through web-based technologies. This selection has been made to achieve personal benefits for the information sharing by using team.sPace. Prior to this study the group used neither an integrated environment for sharing web-resources and weblogs nor similar tools for other types of resources.

14 persons volunteered in the team.sPace study of a period of nine weeks. During this period the participants should set team.sPace as the starting page of their web browser. For participating in the study, the participants had to register on the team.sPace website. During the registration, the participants were automatically assigned to one of the indicators. In order to guarantee to have about the same number of participants in each group, the selection algorithm assigned the participants alternating into the two groups.

Once registered the participants were able to authenticate to the system. The indicators were only available to authenticated users. During the observation period all actions of authenticated visitors were stored in a database. This action logging was used to aggregate the information for the indicators, as well as for the analysis of the user activities after the observation period. The recorded information included the accesses of the team.sPace website (visits), the access of resources (reading actions), filtering using tags in the tag cloud, social bookmarking, and weblog contributions. Because bookmarking and contributing weblogs were actions that were performed not within team.sPace, contributing participants could be active, even without visiting team.sPace directly.

Regarding the research questions the visits to the portal are important, because the related actions are directly linked to the visibility of the indicator. In terms of the interaction footprints recorded by team.sPace, engagement is translated as *more actions per visit at the system's portal*. The other actions can be considered as indicators for the engagement of the participants. Therefore, we analysed the relation of the visits with the other actions.

For getting also a qualitative impression of the participants' experience we selected 6 participants, who were interviewed individually in a face-to-face meeting. We interviewed three participants of each group. In each group one participant contributed both bookmarks and weblogs to the community, one contributed only bookmarks, and one did not contribute at all. We selected the interview partners according to the frequency of using the system, according to their user type, and according to the treatment that they have received. All interviews were semi-structured and lasted between 20 and 30 minutes. During the interview we asked the participants to reflect about their use of team.sPace, about the parts of the system, which they liked and disliked, and about their impression of the indicator that was available to them.

Results

Of the 14 persons who registered themselves to team.sPace 7 participants were assigned to the performance indicator and 7 were assigned to the activity indicator. Five participants registered their research weblog in team.sPace; 8 participants registered their nick name for delicious.com. All participants who contributed their weblogs also contributed their delicious.com bookmarks.

Out of the 14 participants 4 stopped using the system directly after registration, of these participants 1 was assigned to the performance indicator. Another 2 participants were excluded from the evaluation, because they registered and defined the contributing services, but never visited the system afterwards. After this cleaning of participant information, 4 participants were assigned to the performance chart and 4 participants had access to the activity counter.

The contributing participants posted 549 bookmarks and 48 weblog entries over the three month period of the study. During this period the team.sPace portal has been visited 232 times by the participants. The participants followed 153 times a link to a contribution and used 140 times a tag of the tag could to filter the information on team.sPace.

Interaction footprints

Due to the small number of participants, the data from the user tracking is descriptive. It is used to highlight some trends that were observed during the study. However, these trends can only be read within the context of the interviews that are discussed later in this paper. This is relevant because we argue based on the grounds of qualitative data, drawn from the user tracking that is presented below.

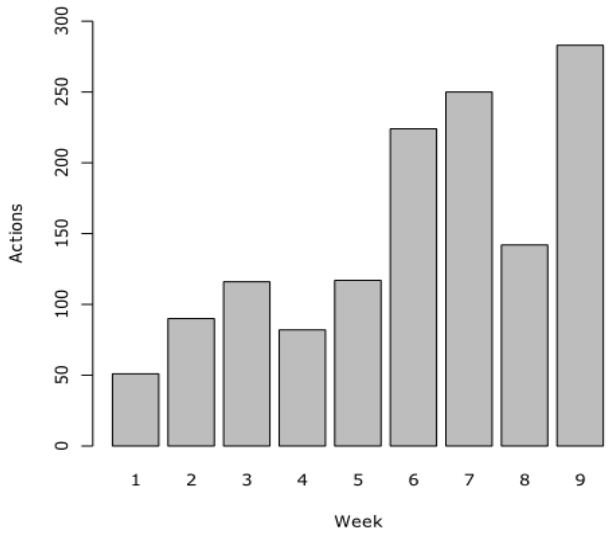

Figure 4: weekly user activity

When analysing the activities over time, it shows that the number of activities is increasing throughout the observation period (see Figure 4). If the actions are separated with respect to the groups that used the different indicators, it is remarkable that the majority of the actions has been performed by the group who was assigned to the performance chart, while the participants in the group that used the action counter was constantly less active during the same observation period (see Figure 5).

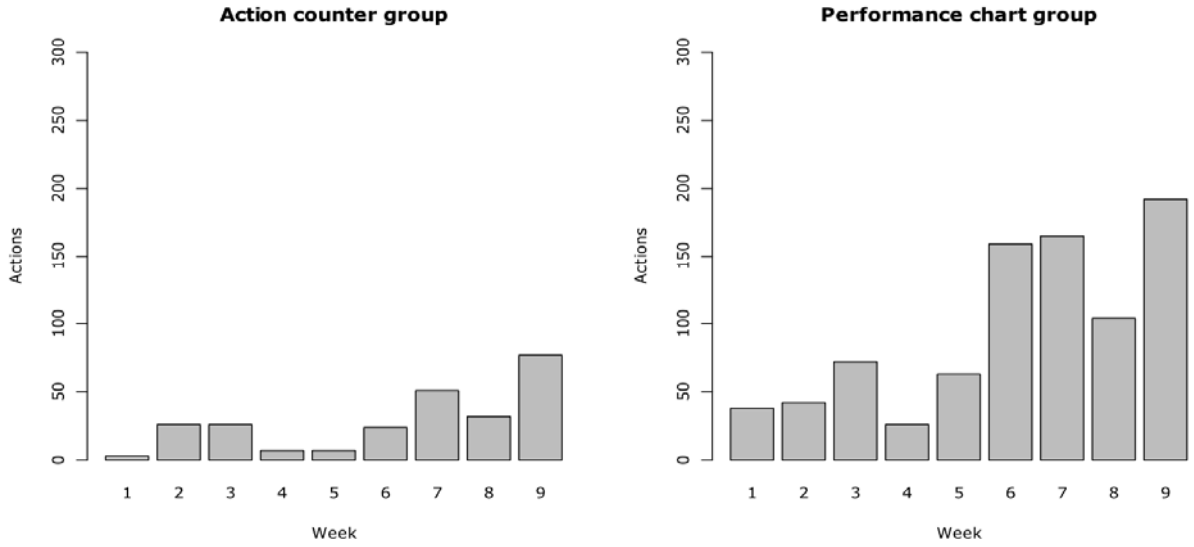

Figure 5: absolute weekly activity by indicator group, excluding visits

Given to this difference in activity, we were interested if this difference can also be observed with respect to visits on the portal. Interestingly, similar visiting patterns of the team.sPace portal were found for both groups (see Figure 6). In other words, the participants of both groups used team.sPace in a comparable way, regardless to which indicator they were assigned to. Also the visits appear to be unrelated to the activity of each group.
For the participants who were assigned to the performance chart we found, that the increasing activity was entirely caused by the contributing participants of that group.

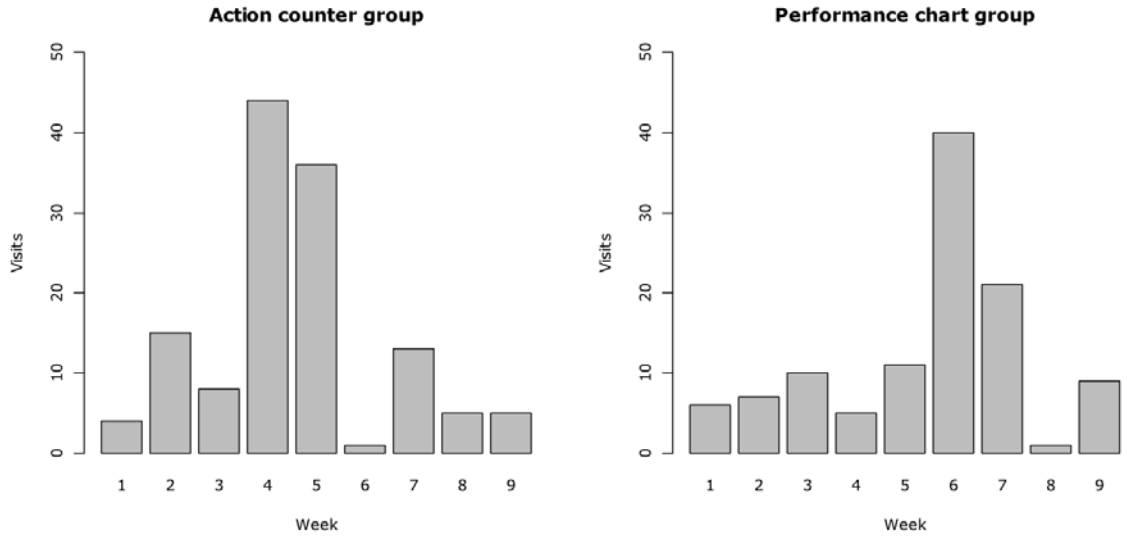

Figure 6: comparison of the absolute weekly visits by indicator group

Interviews

After the observation period, we selected six participants for interviews. Each interview partner was asked the same three questions that are listed in the method section above.

All interviewed participants replied on the first question about their general use of the system, that they frequently visited the portal, but they admitted that they did not use it as a start-up page of their browser. Instead they visited the page when it suited their working schedule. In these cases the participants checked what the other participants were bookmarking or posting on their weblogs. Nevertheless, they followed links only, if its abstract was interesting.

The interviewed participants reported that they liked the content organisation of team.sPace for providing a quick overview of the topics the other group members were dealing with. The participants that were contributing social bookmarks and weblogs reported that through team.sPace they started to estimate features of the external systems that they used prior to the study, already. An example of such experiences was the ability to comment bookmarks in delicious.com. Although adding notes and comments to bookmarks is an integral feature of all bookmarking systems, it is rarely used by default. However, in a group context, the comments can be used to highlight special features of a URL that is relevant to the community. Another example was provided by two participants: they reported that they learned about the value of social bookmarking when it is used within a group. One participant mentioned realising this as a surprise, because the participant used delicious.com for some time before the launch of team.sPace.

With regard to the general use of the system, the participants who received the performance indicator were also focussing more consciously on the quality and quantity of the contributions of the other participants. One contributing participant was complaining about link “stealing”, when others bookmarked links that were previously posted by that participant on team.sPace and – from the perspective of that participant – received performance points for that. The other contributing participant was contributing only social bookmarks and mentioned that the “bloggers” were “ruining” the performance by posting three or four postings almost simultaneously.

For the participants from the activity indicator group none of the interviewed contributors mentioned their recognition of such dynamics on team.sPace during the interviews. However, the participants of this group reflected more about their experiences with the usability and the interface functions of team.sPace.

All interviewed participants reported that they disliked the content browsing feature of team.sPace. They found the collaborative tag cloud little helpful to find the contents they were looking for. One participant reported that it was not able to find a contribution via the tag cloud, although the participant remembered that the entry was on team.sPace. The participants would have also liked to see the tags that were related to an entry. Furthermore, the participants were requesting a peer information feature, which provides a link to the participant's weblog, a link to the bookmarks on delicious.com, user based content filtering, or the tags that were used by another participant. Finally, the authentication procedure was not well received by the participants.

Regarding the question, how the participants experienced the indicators that were displayed to them, the two groups responded very differently. Those participants, who saw the activity indicator, responded that they checked their indicator at the beginning of the observation, and used it for finding out how the indicator responds to which interactions. Two within this group even “admitted” that they “tricked” the system to gain more points. However, for all three participants of this group the indicator lost its attraction after a while and the all three participants used team.sPace mainly as a working group news portal, and in case of the contributors they contributed at their own pace. The participant, who was contributing bookmarks and weblog entries, stated that the indicator was “irrelevant for visiting” the portal.

The group who received the performance indicator answered differently. All three participants reported similar to the first group that they were playing around with the system in order to get familiar with the impact of their activities on the indicator at the beginning of the observation period. Because the underlying aggregator weights the different activities, it is more challenging for non-contributors to keep their performance up with the group. The non-contributing participant of this group reported this experience as “frustrating”, because the “bloggers” and “taggers” get all the points while the own activity chart hardly took off. In this particular case this frustration lead to a counter reaction: the participant created a new delicious.com account and posted a few links in order to see their impact on the performance. After the short reaction phase the participant did not contribute any other resources.

The contributing participants perceived the performance indicator more positive and connected it to the challenge of keeping up and out perform the community. In the interview both participants even asked if the indicator was displaying random information, because sometimes they estimated their performance better than what the indicator displayed. Nevertheless, both participants managed to become superior to the group and gain a maximum peek on the chart. According to the participants, this was very satisfying. The participant who contributed only bookmarks via delicious.com made this even a personal objective, which was reported as "pretty challenging" because of the random "waves" of weblog postings. Both participants reported that they followed the dynamics of the contributions carefully, as they related them to their impact on the performance indicator. Besides this generally positive connotation, both participants also mentioned that while they were "under performing" the indicator was a constant reminder. The participant who contributed both, bookmarks and weblog entries, reported "high pressure" in those cases when the personal performance chart was dropping and there was no time for new contributions due to other obligations.

Discussion

The results of the observation provide some insights regarding the research questions for the design of using visualisation of interaction footprints for learner support With this regard, the combination of the analysis of interaction footprints and the results of the interviews allow us to indicate a trend. This trend is related on the different effects of the two indicators on the engagement of the different groups that was reported in the interviews. For initial validation of our research questions, the interviews need also to be confirmed by the interaction footprints of the participants.

The results do not allow to answer the research questions 1 and 4, because in both cases we were not able to attract enough participants. In case of question 4 the interview with a non-contributing participant in the performance chart group suggest that this question might get positively answered with a larger group of participants. A similar suggestion cannot be made for research question 1.

While both groups were initially attracted by understanding the relation between their activities and the visualisation of the indicator, after the initial phase of using the system the participants using the activity counter were less engaged with the group. Instead their responses focussed more on the general functions and usability of team.sPace. Particularly the responses from the contributing participants support the second research question.

The responses of participants from the performance indicator group had a greater emphasis on recognising the group dynamics with a strong relation to valuing mechanisms of their activities related to team.sPace. With that regard, the responses of the contributing participants are in line with the expectation of research question 3.

The interaction footprints confirm our conclusions to some extend. Particularly, by relating the visits and the overall activity of the participants, the interviews are in line with the research questions 3 and 4. The presumption was that contributing participants will be more engaged in contributing to the community if they are exposed to the performance chart. I.e., they should perform more actions per visit than other participants of team.sPace. This is supported by the interaction footprints of the participants as Figure 7 illustrates.

Figure 7 shows the relation of visits to team.sPace and all other actions per participant. This diagram shows that all three contributors of the performance chart group performed relatively more actions than the three contributors who had access to the action counter.

The findings are in line with the research questions 2 and 3 by the interviews and the interaction footprints suggests that the *social affordance* of interaction visualisations is sensitive to the level of *participation*. Although confidence provided by the data of our study is limited, the finding is important for our research in two ways. Firstly, *participation* is suggested as a contextual dimension, as it was initially proposed by Lave (1993). Secondly, within their limitations the findings indicate that providing a standard visualisation of interaction footprints to all users, does not meet the needs of all users in the same way. The effects might be positive for some, but this is not guaranteed for all participants.

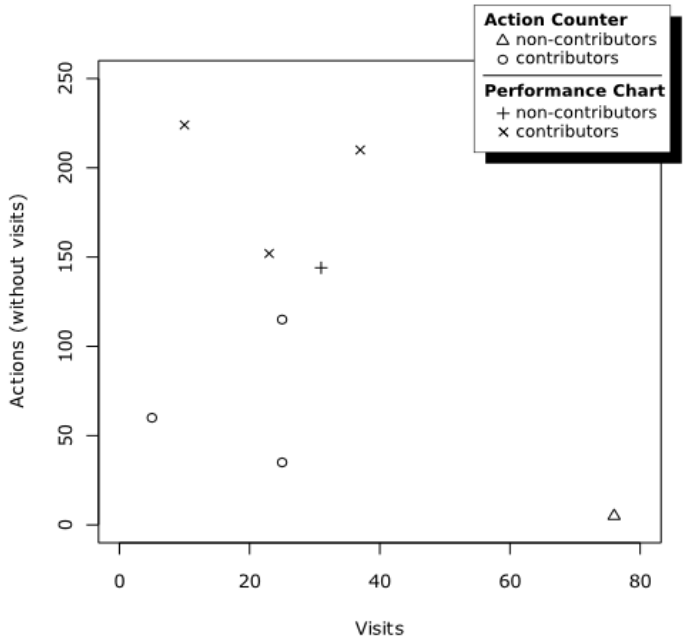

Figure 7: visit to action per participant relation

As the relations between context dimensions and factors of Lave (1993) and Wenger (1998) predicted, our findings suggest that the participants in the performance chart group were more sensitive towards the social dynamics and topics within team.sPace. The reports are interesting because the participants did not spend more effort in studying the contents on team.sPace. This might be a side effect of the *playing the system* that has been reported by the participants of the performance chart group. Such playing appears to have positive effect on the participants' reflection on contents and social dynamics. This finding is relevant for supporting self-directed learning for two reasons: firstly, the participants reflected more on their social context and contextualized their activities to the community; secondly, the indicator itself contains no content related information and provides only limited information about the social dynamics. We relate this effect to the presence of the indicator, because all other information was the same for all participants in this study. Future research will have to focus on this effect more thoroughly.

Conclusions

In this paper we analysed if two different visualisations of interaction footprints have different effects on the engagement of participants in an online community portal. The goal of this study research was to identify variables and conditions for selecting and adapting visualisations of interaction footprints in order to facilitate context sensitive learner support in informal learning. For this purpose the visualisations were embedded in a setting of collaborative information management. This setting was in use for nine weeks. To understand the effects on the different user groups, we analysed the interaction footprints of the participants and selected participants were interviewed about their experiences with the system.

We compared the results of the user actions with their interviews, in order to identify if the level of participation can be used as a dimension for contextualisation, as it has been suggested by previous educational literature. As expected for an initial design study, the results do not provide "hard" evidence. However, the trend of the results supports the research presumption that the learners' perception of their activity visualisations is context dependent. Moreover, we found that more engaging visualisation also polarised the participants in this group: while contributing participants were attracted to contribute more to the community, it appeared that non-contributing participants got distracted by the same visualisation.

From the results of this qualitative study it can be suggested that the concept of social affordance (Kreijns, 2004) is context dependent. With regard to information visualisation, this implies that the same visualisation can influence learners differently, depending on their level of participation. This supports the initial research question for the design of the adaptation strategy that motivated our research.

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